AASHTO M 323 – STANDARD SPECIFICATION FOR SUPERPAVE VOLUMETRIC MIX DESIGN

1. Which of the following describes binder requirements?
   a. Must be performance graded meeting the requirements of AASHTO M 320.
   b. Must be appropriate for climate and traffic loading of the project for which it is intended.
   c. Must meet the requirements of SP 1 published by the Asphalt Institute.
   d. a & b
   e. All of the above.

2. When RAP (Reclaimed Asphalt Pavement) is used in a Superpave mix design, which of the following best describes what must be done when selecting the virgin binder grade?
   a. Select a binder one grade softer than normal when the RAP percentage is not greater than 15%.
   b. Select a binder one grade stiffer than normal when the RAP percentage is between 15 and 25%.
   c. Select a binder one grade softer than normal when the RAP percentage is greater than 25%.
   d. None of the above.

3. Which of the following are gradation control points or sieves?
   a. Maximum size.
   b. Nominal maximum size.
   c. One sieve smaller than nominal maximum size.
   d. Primary control sieve.
   e. b & c
   f. All of the above.
   g. Who knows?????

AASHTO R 35 – STANDARD PRACTICE FOR SUPERPAVE VOLUMETRIC MIX DESIGN

4. Using the table on the following page, what is the combined percent passing for the No. 4 sieve?
   a. 53
   b. 54
   c. 55
   d. 56
   e. None of the above.

   P = Aa + Bb Cc + . . . Nn

   Where:

   A, B, C …N = Percent passing for individual products (expressed as whole numbers).

   a, b, c, … n = Proportions of individual products used (expressed as decimals).

5. Using the table on the following page, what is the combined G_{sb}(OD) (oven-dry bulk specific gravity) of the blend?
   a. 2.655
   b. 2.657
   c. 2.659
   d. 2.661
   e. None of the above

$$G_{sb}(OD) = \frac{P_1 + P_2 + P_3 + \ldots\ldots\ldots\ldots P_n}{\frac{P_1}{Gsb(OD)_1} + \frac{P_2}{Gsb(OD)_2} + \frac{P_3}{Gsb(OD)_3} + \ldots\ldots\ldots \frac{P_n}{Gsb(OD)_n}}$$

Aggregate Blending Worksheet

Product Identification	Percentage of Products Used (Decimal)				
	Blend No. 1	**a** (1/2")	**b** (3/8")	**c** (1/4")	**d** (Fine)
A (1/2")	**0.23**	0.23			
B (3/8")	**0.22**		0.22		
C (1/4")	**0.17**			0.17	
D (Fine)	**0.38**				0.38
Total	**1.00**				

Grading for 1/2" (12.5 mm) Mix					
Sieve Size	**Comb.**	Individual Product Contributions			
1"	**100**	23	22	17	38
3/4"					
1/2"					
3/8"					
No. 4					
No. 8					
No. 16					
No. 30					
No. 50					
No. 100					
No. 200					
Combined Specific Gravity and Absorption Data					
G_{sb} (OD)					
G_{sb} (SSD)					
G_{sa}					
Absorption					

Individual Product Identification and Gradations (Percent Passing)				
Sieve Size	**A** (1/2")	**B** (3/8")	**C** (1/4")	**D** (Fine)
1"	100	100	100	100
3/4"	100	100	100	100
1/2"	91	100	100	100
3/8"	12	96	100	100
No. 4	2	20	75	100
No. 8	2	15	21	95
No. 16	2	5	10	78
No. 30	1	2	5	46
No. 50	1	2	3	25
No. 100	1	2	3	18
No. 200	0.3	1.5	2.0	10.3
Individual Aggregate Specific Gravity and Absorption Data				
G_{sb} (OD)	2.802	2.641	2.589	2.610
G_{sb} (SSD)	2.810	2.654	2.626	2.635
G_{sa}	2.826	2.676	2.689	2.677
Absorption	0.30	0.45	0.98	0.90

Additional Design Information for Calculation of P_{bi}	
Binder Specific Gravity G_b	1.022
Log S_n (12.5)	1.0969

6. Which of the following is required for calculation of the P_{bi} (initial trial binder content)?
   a. G_{sb}(OD) and G_{sa}
   b. G_{sb}(SSD) and G_{sa}
   c. Estimated G_{se}
   d. a & c
   e. b & c
   f. All of the above.

7. Given the following information, the VMA is _____.
   a. 12.4%
   b. 17.5%
   c. 87.6%
   d. 82.5%
   e. None of the above.

$$VMA = 100 - \left(\frac{G_{mb}\, P_s}{G_{sb(OD)}} \right) \qquad V_a = 100 \times \left[1 - \left(\frac{G_{mb}}{G_{mm}} \right) \right]$$

where:
G_{mm} = 2.479
G_{mb} = 2.335
P_s = 94.3%
$G_{sb(OD)}$ = 2.668

8. Given the above information, the V_a is _____.
   a. 5.8%
   b. 5.9%
   c. 94.2%
   d. 94.3%
   e. None of the above.

9. Given the VMA calculated in question number 7 above, the VMA would be considered appropriate for a 1/2" (12.5mm) Superpave mix design.
   a. True
   b. False

10. During the optimum binder content selection phase of volumetric mix design, five binder contents are used.
    a. True
    b. False

11. Given the following, what is the $\%G_{mm(initial)design}$? Does this meet the Superpave requirements where Design ESALs are 14 million (Yes/No)?
    a. 88.1% - - Yes
    b. 89.9% - - Yes
    c. 88% - - No
    d. 90% - - Yes
    e. None of the above.

$$\%G_{mm(initial)} = 100 \times \left(\frac{G_{mb}\, h_d}{G_{mm}\, h_i} \right)$$

$$\%G_{mm(initial)design} = \%G_{mm(initial)} - \Delta V_a$$

where:
V_a at nearest lower binder content than that resulting in 4.0% = 5.8%
G_{mm} = 2.502
G_{mb} = 2.467
h_d = 116.8 mm
h_i = 130.7 mm

12. Final selection of optimum design binder content is based on compliance with Table 3 ("Superpave HMA Design Requirements") as shown in the FOP for AASHTO R 35. For design ESALs of 7 million, the following meet the requirement.
    a. True
    b. False

Where:

$\%G_{mm}$ @ N_{inial} :	89.8
$\%G_{mm}$ @ N_{design}:	96.0
% G_{mm} @ N_{max}:	98.9
VFA:	68.1%
$P_{0.075}/P_{be}$:	1.4%

AASHTO R 30 MIXTURE CONDITIONING OF HOT-MIX ASPHALT (HMA)

13. Which of the following statements regarding this FOP is correct?
    a. Mixture conditioning procedures for volumetric design and mechanical property testing are the same except for the period of aging (2 hours vs. 4 hours).
    b. Mixture conditioning according to R 30 simulates long-term aging of the mix.
    c. Conditioning in the laboratory is not necessary prior to volumetric mixture testing of plant-produced HMA.
    d. After mixture conditioning of gyratory compaction samples is completed, it is permissible to allow the sample to cool to room temperature temporarily before reheating to compaction temperature.
    e. All of the above.

14. According to this FOP, which of the following statements is **incorrect**?
    a. Prior to laboratory-mixing samples for volumetric testing it is required to first prepare, mix and discard a butter batch.
    b. Mixture conditioning of samples for volumetric mixture design is conducted at mixing temperature for a period of 2 hours ± 5 minutes.
    c. Mixture conditioning for mechanical property testing is conducted at 275˚F for a period of 4 hours ± 5 minutes.
    d. When performing mixture conditioning for mechanical property testing it is required to stir the samples every 60 ± 5 minutes.
    e. All of the above.

15. According to this FOP, when RAP (Reclaimed Asphalt Pavement) is used in volumetric mix design, it must be added to the aggregate for the period required to heat the aggregate to mixing temperature (usually 2 to 4 hours).
    a. True
    b. False

AASHTO T 312 – METHOD FOR PREPARING AND DETERMINING THE DENSITY OF HOT MIX ASPHALT (HMA) BY MEANS OF THE SUPERPAVE GYRATORY COMPACTOR

16. The angle of gyration may refer to either the internal or external angle.
    a. True
    b. False

17. The angle of gyration and pressure applied during compaction must be within a specified range. The correct angle is _____; the correct pressure applied during compaction is _____.
    a. 1.25±0.02º - - 600±18 Pa.
    b. 1.16±0.02º - - 600±16 kPa.
    c. 1.25±0.02º - - 600±18 kPa.
    d. 1.16±0.02º - - 600±16 Pa.
    e. None of the above.

18. This FOP covers preparing gyratory-compacted specimens that may be used for field control of HMA production processes.
    a. True
    b. False

19. After filling the mold, leveling the HMA and installing the paper disc, what next must be done?

_____

_____

_____

_____

AASHTO T 283 – RESISTANCE OF COMPACTED BITUMINOUS MIXTURES TO MOISTURE INDUCED DAMAGE

20. Test specimens for T 283 must be compacted to what air void content?
    a. Between 5 and 7 percent.
    b. Between 6 and 8 percent.
    c. Between 6 and 7 percent.
    d. Between 6.5 and 7.5 percent.
    e. None of the above.

21. After saturation it is discovered that the degree of saturation is 65%. What must be done? If the degree of saturation is 81%, what must be done?
    a. For saturation of 65% it is permissible to repeat the saturation process using more vacuum and/or time. For saturation of 81% it is permissible to dry the specimen sufficiently to bring the saturation to within the acceptable 70 to 80% range provided that drying is performed at a temperature of 125 ± 5ºF or lower.
    b. In both cases, the specimen(s) must be discarded because it is never permissible to make further adjustment to specimens outside the range of acceptable saturation.
    c. For saturation of 65% it is permissible to repeat the saturation process using more vacuum and/or time. For saturation of 81% the specimen is damaged and must be discarded.
    d. None of the above.

22. Given the following, calculate the TSR. Does TSR meet Superpave requirements?

$$TSR = \frac{S2}{S1}$$

where:
S1 = unconditioned subset - 133 psi indirect tensile strength
S2 = conditioned subset – 97 psi indirect tensile strength

AASHTO T 324 – HAMBURG WHEEL-TRACK TESTING OF COMPACTED HOT-MIX ASPHALT (HMA)

23. According to this FOP, test specimens for T 324 must be compacted to what air void content?
    a. Between 5 and 7 percent.
    b. Between 6 and 8 percent.
    c. Between 6 and 7 percent.
    d. Between 6.5 and 7.5 percent.
    e. None of the above.

24. Which of the following specimen sizes are appropriate for testing according to this FOP?
    a. Laboratory-compacted slab specimens of 12.5 inch length and 10.25 inch width having thickness of 1.5 inch to 4 inch.
    b. Superpave gyratory compactor specimens having thickness (height) of 1.5 inch to 4 inch.
    c. Wet-cut compacted specimens from HMA pavements. Slabs shall be of approximately 12.5 inch length and 10.25 inch width and thickness of 1.5 inch to 4 inch. Cores shall be 10 inch diameter.
    d. All of the above.

25. Describe how the SIP (stripping inflection point) is determined by using the creep slope and stripping slope.

AASHTO M 325 – STANDARD SPECIFICATION FOR STONE MATRIX ASPHALT (SMA)

26. Stone Matrix Asphalt (SMA) is an open-graded Hot Mix Asphalt (HMA) mixture with stone-on-stone contact.
    a. True.
    b. False.

27. According to this FOP, which of the following statements is true?
    a. Stone-on-stone contact is defined as the point where the VCA_{DRC} is less than the VCA_{MIX}.
    b. The SMA aggregate specification is based on compliance with all of the Consensus Aggregate Properties, including Sand Equivalent, Coarse Aggregate Angularity (Fractured Face), Fine Aggregate Angularity (Uncompacted Void Content), and Flat & Elongated Particles.
    c. Aggregate quality requirements vary based on design ESAL's and depth from the pavement surface.
    d. Coarse and fine aggregates shall be 100 percent crushed (no natural uncrushed material).
    e. All of the above.
    f. None of the above.

28. According to this FOP, which of the following statements is **incorrect**?
    a. SMA mix design is based on volumetric properties in terms of air voids (V_a), voids in mineral aggregate (VMA), and the presence of stone-on-stone contact.
    b. Binder must comply with AASHTO M 320, and be appropriate for the climate and traffic loading of the project.
    c. Mineral fillers with modified Rigden voids higher than 50 percent should not be used in SMA because such fillers excessively stiffen the SMA mortar.
    d. SMA is a gap-graded HMA mixture consisting of a coarse aggregate skeleton with stone-on-stone contact and a rich asphalt binder mortar.
    e. When the G_{sb}(OD) of the different materials to be used in the mixture vary by more than 0.2, the trial blend grading shall be based on percentage by mass.

AASHTO R 46 – STANDARD PRACTICE FOR DESIGNING STONE MATRIX ASPHALT (SMA)

29. VCA_{DRC} is the volume of voids between coarse aggregate particles in the combined gradation in the dry-rodded condition. VCA_{DRC} is calculated based on the G_{sb}(OD) of the coarse aggregate fraction of the combined grading, G_{mb} of the compacted specimens, and the percentage of coarse aggregate used in the mixture.
    a. True.
    b. False.

30. According to this FOP, which of the following statements is true?
    a. Selection of the optimum aggregate gradation is based in part on the volumetric property results of a minimum of three trial mixtures, compacted using the Superpave Gyratory Compactor (SGC).
    b. When no previous history is available, a starting trial blend binder content between 6.0 and 6.5 percent is required. Trial binder content is selected, in part, based on volume of absorbed binder (V_{ba}), volume of effective binder (V_{be}), and estimated effective specific gravity (G_{se}) of the combined aggregate grading.
    c. Selection of optimum binder content is based on the results of mixtures with four varying binder contents (at P_{b_est}, 0.5% below, 0.5% above, and 1.0% above P_{b_est}).
    d. a & b
    e. b & c
    f. All of the above.

31. Given the following, for Aggregate A, calculate the individual percent retained on the No. 8 sieve. What is the individual volume retained on the No. 8 sieve?

Individual % retained: _____. Individual volume retained: _____ cm^3.

$$V = \frac{M}{D}$$

Sieve Size	Cumulative % Passing for Product Identification and Percent Usage			
	Aggregate A 35% (a)	Aggregate B 24% (b)	Aggregate C 30% (c)	Mineral Filler (D) 11% (d)
3/4"	100.0	100.0	100.0	100.0
1/2"	65.8	71.2	97.4	100.0
3/8"	42.6	46.4	84.6	100.0
No. 4	9.7	6.3	48.9	100.0
No. 8	4.1	4.1	27.8	100.0
No. 16	2.6	3.1	16.6	100.0
No. 30	2.4	2.9	10.7	100.0
No. 50	2.1	2.6	7.6	100.0
No. 100	1.4	1.8	5.4	89.7
No. 200	1.2	1.7	4.6	72.5
– No. 200				
G_{sb}(OD)	2.536	2.782	2.838	2.425

32. Given the grading information in the table above, what is the individual volume retained for the combined grading on the No. 8 sieve?

_____ cm^3

$$IVR = (VRA \times a) + (VRB \times b) + (VRC \times c) + ...(VRN \times n)$$

AASHTO T 305 – STANDARD METHOD OF TEST FOR DETERMINING DRAINDOWN CHARACTERISTICS OF UNCOMPACTED ASPHALT MIXTURES

33. Draindown is defined as that portion of the asphalt binder that separates itself from the sample during the test?
    a. True.
    b. False.

34. According to this FOP, which of the following statements is true?
    a. The standard basket is manufactured of 1/4" sieve cloth as specified in AASHTO M 92. The basket has nominal diameter of 4.25 in. with the bottom of the basket elevated above the bottom of the assembly (so material can drain from the basket).
    b. When performing draindown tests during mixture design, two temperatures are selected, plant production temperature and 27 ºF above plant temperature.
    c. If the sample cools more than 45 ºF below the required temperature, the test duration must be increased from 60±5 minutes to 70±5 minutes.
    d. a & b
    e. b & c
    f. All of the above.

35. Using the information below, calculate the reported average drainage.

$$\% \text{ Draindown} = \frac{M_f - M_i}{M_t} \times 100$$

known:

	Sample 1	Sample 2
Mass of empty basket	2056.8 grams	2063.4 grams
Mass of basket and sample	3287.9 grams	3271.3 grams
Mass of clean plate prior to draindown (M_i)	15.6 grams	15.8 grams
Mass of plate and contents after draindown (M_f)	21.3 grams	19.1 grams

Agency reports drainage to the nearest 0.1%

Average Drainage: _____